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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 :
E21B 15/04, E21D 20/00

A1

(11) International Publication Number: WO 00/60211

(43) International Publication Date: 12 October 2000 (12.10.00)

(21) International Application Number: PCT/IB00/00418

(22) International Filing Date: 6 April 2000 (06.04.00)

(30) Priority Data:
99/2554 7 April 1999 (07.04.99) ZA

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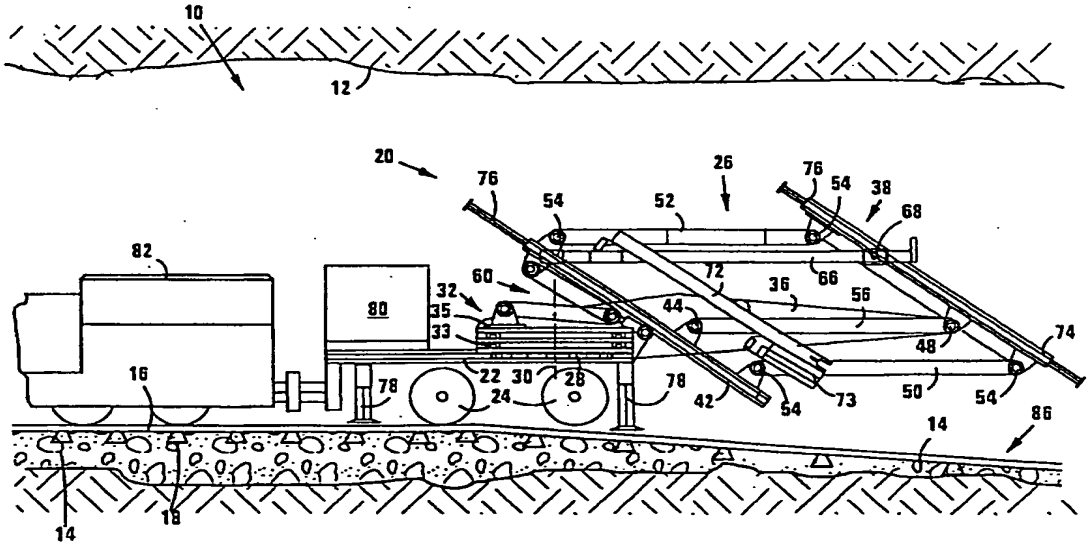
(81) Designated States: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: A DRILL RIG FOR USE IN AN UNDERGROUND MINE



(57) Abstract

The invention provides a drill rig (20) for use in an underground mine. The drill rig (20) includes a boom support structure in the form of a collapsible frame (26). The drill rig (20) includes a chassis (22) on which the frame (26) is mounted such that it is displaceable relative to the chassis about an upwardly directed pivot axis (30) and is laterally displaceable relative thereto. At least one tunnelling drilling boom (66) is mounted on the frame on which a drill (70) is slidably mounted for drilling blast holes. In addition, at least one roof drilling boom (72) is mounted on the frame (26) on which a drill (73) is mounted for drilling bolt holes in a roof of a tunnel. The frame is displaceable between an erect condition in which drilling can take place and a collapsed condition in which it is of reduced height to facilitate transport of the drill rig (20) in a mine tunnel.

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A DRILL RIG FOR USE IN AN UNDERGROUND MINE

THIS INVENTION relates to mining. More particularly it relates to a drill rig for use in an underground mine.

The Inventor believes the invention will find application particularly in tunnelling operations in underground mines.

Conventionally, in South African mines, holes required for blasting and support purposes in tunnelling operations are drilled, using hand held rock drills mounted on pneumatic air legs.

The Inventor is aware that various single or multi-boom drill rigs for the mechanical drilling of such holes are available but that these drill rigs have certain constraints. Generally, when these drill rigs are used, blast hole lengths are drilled at as great a length as is practical to improve the economical viability of the capital investment. The lengths of the booms required for the drilling of such holes are then such that they cannot be rotated so as to drill roof bolt support holes unless a telescopic boom is used. In addition, the procedure of positioning these booms at the various blast hole positions requires specialised skill or a complex and expensive computer controlled system.

It is an object of this invention to provide means which the Inventor believes will at least alleviate some of these problems.

According to one aspect of the invention there is provided a drill rig for use in an underground mine which includes a boom support structure on which at least one drilling boom is displaceably mounted or mountable, the boom support structure being displaceable between an erect condition and a collapsed condition to facilitate transport of the drill rig in an underground mine.

Hence, in its collapsed condition the boom support structure will typically be of reduced height compared to its height when in its erect condition.

The boom support structure is preferably in the form of a collapsible frame.

The drill rig may include a wheeled chassis on which the frame is mounted. The frame may be mounted on the chassis so that it is pivotally displaceable relative thereto above an upwardly directed pivot axis and is laterally displaceable relative thereto. The drill rig may include a turntable mounted on the chassis for rotation above the pivot axis and a slide arrangement whereby the frame is mounted on the turntable for lateral displacement relative thereto. The slide arrangement permits the side-to-side or transverse positioning of the frame so that vertical laterally spaced lines of blast holes can be drilled according to a predetermined pattern.

The drill rig may include a pair of elongate transversely spaced apart frame supports connected to and protruding from the slide arrangement, the frame including a plurality of interconnected frame members, at least some of which are pivotally connected to the frame

supports to permit displacement of the frame between its erect and its collapsed conditions.

The frame may include two transversely spaced sets of frame members, each set of frame members comprising a rear upright member and a front upright member which are pivotally connected to one of the frame supports, a bottom member pivotally connected to the front and rear upright members adjacent their lower ends and a top member pivotally connected to the front and rear upright members adjacent their upper ends such that in the erect condition of the frame, each set of frame members is generally in the form of a square or rectangle and in the collapsed condition of the frame, each set of frame members is in the form of a parallelogram, and a plurality of transverse connecting members connecting the sets of frame members together.

The drill rig may include displacement means for displacing the frame between its erected and collapsed conditions.

The drill rig may include retractable outrigger jacks mounted on the chassis. Preferably four outrigger jacks are provided, the jacks being used in supporting the drill rig and moving it into its required elevation and level orientation for drilling. The outrigger jacks also serve the purpose of stabilizing and anchoring the drill rig arrangement.

The drill rig may include at least two transversely spaced tunnelling drilling booms displaceably mounted on the frame. Preferably, one tunnelling drilling boom is mounted on each set of frame members such that it is vertically displaceable relative thereto. This arrangement permits the drilling of a vertical line of blast holes in any position which

follows the plane defined by the rear and front upright members of each set of frame members. Further, the tunnelling drilling booms and drills mounted thereon can operate simultaneously and independently.

The drill rig may include at least one roof drilling boom displaceably mounted on the frame. Preferably, the drill rig includes at least two roof drilling booms mounted to the frame to permit for the drilling of roofbolt holes in a plane which is generally perpendicular relative to the direction of the tunnelling drilling booms. The roof drilling booms are positioned a predetermined distance apart according to particular requirements.

In a preferred embodiment of the invention, both the tunnelling drilling booms and the roof drilling booms are attached to the frame in such a way that when the frame is collapsed for the purpose of transportation of the drill rig along the tunnels, the tunnelling drill drilling booms remain in a generally horizontal orientation and the roof drilling booms are inclined generally parallel to the upright frame members.

The drill rig may include anchor means for anchoring the frame in position.

The anchor means may include extendible jacks mounted on at least some of the front upright members and rear upright members the jacks being configured when extended, to extend beyond the extremities of the associated frame members to abut against the roof and floor of a tunnel in a mine. These jacks are extended once the frame is orientated into a drilling position and retracted whenever the frame is to be repositioned. The jacks serve to anchor the frame in preparation for and

during drilling and to support the roof of the tunnel where drilling is taking place.

According to another aspect of the invention there is provided a drill rig for use in an underground mine which includes

a boom support structure;

at least one tunnelling drilling boom adjustably mounted on the boom support structure; and

at least one roof drilling boom adjustably mounted on the boom support structure and extending generally orthogonally to the tunnelling drilling boom.

The drill rig may include a wheeled chassis on which the boom support structure is mounted such that it is pivotally displaceable relative to the chassis about an upwardly directed pivot axis and it is laterally displaceable relative to the chassis.

The drill rig may include a turntable mounted on the chassis for rotation about the pivot axis and a slide arrangement whereby the boom support structure is mounted on the turntable for lateral displacement relative thereto.

The drill rig may include a roof drilling boom support which is displaceable between an operative position in which it is in contact with a floor of a mine to provide support to the roof drilling boom and an inoperative position in which it is clear of the floor of the mine to facilitate transport of the drill rig in the mine.

The roof drilling boom support may be in the form of a jack mounted on and extendible downwardly from the roof drilling boom.

The boom support structure may be in the form of a collapsible frame.

The drill rig may include a control system for automatically controlling the operation of at least one of the drilling booms. In particular, the control system may be pneumatic and/or electric and be configured automatically to direct the tunnelling drilling boom from each drilling position in its associated operating plane to the next drilling position after completion of each of the drilling cycles. This allows for a single initiating signal to start the sequence of drilling all of the holes required in a vertical line of holes without any further control on the part of the operator.

The drill rig may be disconnectably connectable to a draught vehicle. In one embodiment of the invention, the drill rig may be displaceable forwards and backwards by an independent battery or diesel engine powered locomotive or vehicle. Hence, the draught vehicle can be disconnected from the drill rig when drilling is not taking place and utilized for other purposes.

The invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings.

In the drawings,

Figure 1 shows a section of a mine tunnel in which a drill rig in accordance with the invention is shown in side view with a frame of the drill rig in its collapsed condition;

Figure 2 shows a side view similar to Figure 1 in which the frame of the drill rig is shown in its erect condition ready for drilling of roof bolt holes and/or tunnelling blast holes;

Figure 3 shows a plan view of the drill rig of Figures 1 and 2 in a mine tunnel with the frame of the drill rig in a central position relative to the mine tunnel face;

Figure 4 shows a plan view similar to Figure 3 of the drill rig with the frame offset to the left side of the tunnel;

Figure 5 shows a plan view of the drill rig in a curved mine tunnel with the drill rig frame rotated at a base at an angle relative to the chassis on which it is mounted;

Figure 6 shows a view of the face of a tunnel and the typical lines of blast holes to be drilled;

Figure 7 shows an end view of the drill rig with the frame in its central drilling position in line for the drills to drill the intermediate lines of blast holes on either side of the central line of blast holes shown in Figure 6; and

Figure 8 shows an end view, similar to Figure 7, in which the frame of the drill rig, shown in solid lines, is displaced laterally to the left to drill the left side and central line of blast holes shown in Figure 6 and the frame shown in broken lines is displaced laterally to the right to drill the right side and central line of blast holes.

In the drawings, reference numeral 10 refers generally to part of an underground tunnel in a mine. The tunnel 10 has a tunnel

roof, generally indicated by reference numeral 12 and a floor generally indicated by reference numeral 14.

In addition, in South African gold and platinum mines, transport in tunnels 10 is conventionally conducted using railway cars mounted on steel rails 16 supported on longitudinally spaced apart sleepers 18.

Further, in the drawings, reference numeral 20 refers generally to a drill, rig in accordance with the invention. The drill rig 20 includes a chassis 22 supported on flanged wheels 24 which run on the rails 16. It will be appreciated, however, that the wheels of the chassis 22 could be tyred or of any other suitable form.

The drill rig 20 further includes a boom support structure in the form of a collapsible frame, generally indicated by reference numeral 26.

The drill rig 20 includes a rotating mechanism in the form of a turntable 28 which is mounted on the chassis for displacement relative thereto about an upwardly directed pivot axis 30. A slide arrangement 32 is mounted on the turntable 28 for displacement laterally relative thereto in the direction of arrow 34 (Figure 3). The slide arrangement 32 includes a fixed part 33 which is fixed to the turntable 28 and a displaceable part 35 which is slidable relative to the fixed part. The displacement of the displaceable part 35 relative to the fixed part 33 is typically by means of a pressurized fluid, typically hydraulic, piston and cylinder arrangement.

The drill rig includes a pair of parallel transversely spaced apart frame supports 36 which are connected to the displaceable part 35 of the slide arrangement and protrude forwardly therefrom.

The frame 26 includes two transversely spaced sets of frame members 38, 40. Each set of frame members 38, 40 includes a rear upright member 42 which is pivotally connected via a pivot pin 44 to the associated frame support 36. In addition each set 38, 40 includes a front upright member 46 which is pivotally connected via a pivot pin 48 to the associated support 36. In addition, each set 38, 40 includes a bottom member 50 and a top member 52 which are pivotally connected to and extend between the associated rear and front upright members 42, 46, adjacent their lower ends and their upper ends, respectively, by pivotal connections 54. In addition, an intermediate member 56 extends generally parallel with the bottom and top members 50, 52 and is connected to the rear and front upright members via the pivot pins 44, 48. The frame 26 further includes transverse connecting elements 58 which are connected to and extend between corresponding members in the two sets 38, 40 to secure the sets 38, 40 together. Hence, the frame 26 is displaceable between a collapsed condition (shown in Figure 1 of the drawings) in which the members 42, 46, 50, 52 in each set form a parallelogram and an erect condition (shown in Figure 2 of the drawings) in which the frame members in each set form a rectangle.

Displacement of the frame 26 between its collapsed and erect conditions is achieved by displacement means, generally indicated by reference numeral 60. The displacement means include a pair of displacement arms 62 which are pivotally connected at their one end to

the rear upright members 42 and at their other ends to the displaceable part of the slide arrangement 32. The displacement arms 62 are displaceable by means of an hydraulic piston and cylinder assembly 64 which is pivotally connected at its one end to the displaceable part of the slide arrangement 34 and pivotally connected at its other end to the displacement arms 62 at a position intermediate their ends. It will be appreciated that instead of the piston and cylinder assembly 64 any suitable device, eg a screw drive, could be used for displacing the displacement arms 62.

The drill rig 20 includes two tunnelling drilling booms 66 which are pivotally mounted to slide brackets 68 which are slidably mounted on the upright members 42, 46. The members 42, 46 are fitted with internally located drive mechanisms. These may be hydraulic or pneumatic piston and cylinder assemblies, chain or screw drives or the like whereby the slide brackets 68 are longitudinally displaceable along the members 42, 46. By activating the drive mechanisms simultaneously in the members 42, 46 the tunnelling drilling booms 66 can be raised or lowered in a horizontal orientation to line up the drilling of blast holes using drills 70 which are slidably attached to the tunnelling drilling booms 66 and are propelled along them by a mechanical drive means.

The drive mechanisms in each of the four members 42, 46 may be independently controlled, thereby permitting each tunnelling drilling boom 66 to be positioned anywhere along the members 42, 46 and inclined up to about 7° above or below the horizontal.

The drill rig comprises two roof drilling booms 72 (Figure 2) which are pivotally connected to transverse connecting elements 58.

The roof drilling booms 72 are mounted on the connecting elements 58 in a manner which permits the booms to be inclined in a generally perpendicular plane as illustrated in Figure 8 and to remain generally orthogonal to the tunnelling drilling booms 66. In addition, by moving the position of the transverse connecting elements 58 to which the roof drilling booms 72 are connected relative to the sets of frame members, the roof drilling booms 72 can be spaced at whatever distance is required for roof bolt holes within the limitation defined by the upright members 42, 46. Rock drills 73 are slidably mounted on the roof drilling booms 72 for longitudinal displacement therealong by a drive mechanism.

The drill rig 20 includes anchor means for anchoring the frame 26 in position in its erect condition. The anchor means include hydraulic jacks 74 connected to each of the front upright members 46. The jacks 74 are extendible downwardly into contact with the floor 14 to acts as supports for the frame 26. The anchor means further includes jacks 76 which are mounted on each of the rear upright members 42 and front upright members 46 such that they are extendible upwardly into contact with the roof 12 of the tunnel 10 and serve both to anchor the frame 26 in position and act as support for the roof 14 to reduce the risk of rock falls.

The drill rig 20 further includes four retractable outrigger jacks 78 mounted on the chassis 22 to support the drill rig as described in more detail herebelow.

The drill rig includes a control panel 80 mounted on the chassis 22 for controlling the operation of the drill rig 20.

The displacement of the drill rig 20 from one location to another may be by means of a locomotive 82. Typically, the locomotive 82 will be battery or diesel powered. The locomotive 82 will serve the dual purpose of being a draught vehicle for displacing the drill rig along the rails 16 and also of powering certain functions of the drill rig when it is positioned for drilling holes.

In use, with the frame 26 in its collapsed condition (shown in Figure 1) in which its is of reduced height, when compared with its erect condition (shown in Figure 2), the drill rig 20 is displaced by means of the locomotive 82 to a tunnel face. In its collapsed condition, the drill rig can be displaced along typical mine tunnels without fouling on the roof 12, sides 84 or pipe reticulation typically found in tunnels. Once at the tunnel face 88 the frame 26 is displaced via the displacement means 60 into its erect condition.

In Figures 1 and 2 of the drawings, reference numeral 86 indicates a temporary segment of track stretching from the rails 16 of the permanent track which end typically 12 to 15 meters from the tunnel face 88, to the tunnel face 88. When mine tunnels are being advanced by blasting means, temporary tracks 86 will typically be below the elevation of the permanent track elevation causing the drill rig 20 to be located below the required elevation when situated on this segment of track. Accordingly, before drilling can commence, the drill rig 20 must be elevated to the correct grade by making use of the outrigger jacks 78.

In some instances, the temporary track 86 will, in addition, be misaligned in relation to the direction of the tunnel and not positioned laterally in relation to the sides of the tunnel. Accordingly, once the

chassis 22 has been correctly elevated and levelled using the outrigger jacks 78, then the directional orientation of the frame 26 can be adjusted using the turntable 28 and laterally adjusting the slide arrangement 32.

Once the frame 26 is in a desired position relative to the tunnel face 88 it is anchored in position by extending the jacks 74, 76.

Figure 6 illustrates the tunnel face 88 showing the arrangement of five vertical lines of holes 90, 92, 94, 96, 98 to be drilled in the tunnel face 88 using the drill rig 20.

In practice, a central line of holes 94 would require more holes to be drilled than lines 90, 92, 96 and 98. In some cases, the central line of holes 94 would include the drilling of at least two holes with diameters double that of the other holes.

Typically, the arrangement for drilling the lines of holes would be to start by anchoring the frame on the right hand side of the tunnel and drilling the holes in lines 90 and 94 simultaneously. The jacks 74, 76 would then be retracted and the frame 26 displaced to a central position in which it is anchored by extending the jacks 74, 76. The holes in lines 92 and 96 would then be drilled simultaneously. Finally, the frame will be anchored on the left hand side of the tunnel to drill the holes in line 98 and the balance of holes to be drilled on line 94 simultaneously. The frame 16 would, for this application, be constructed in such a manner that the distance between the drills 70 corresponds to the required distance between the lines of holes.

Figures 3, 4, 7 and 8 illustrate the sliding of the frame 26 from one side wall of the tunnel to the other side wall using the slide arrangement 32 in order to align the drills 70 with the required drilling positions.

Figures 3 and 7 show the frame 26 in an approximate centre position to drill lines of holes 92 and 96. Figures 4 and 8 show the frame 26 on the left hand side of the tunnel and positioned to drill hole lines 94, 98. Figure 8 shows, in broken lines, the frame 26 on the right hand side of the tunnel in position to drill lines of holes 90 and 94. In Figure 5 of the drawings, use of the turntable 28 is illustrated when it is required to drill face holes at an angle to the direction of the tunnel as for negotiating a curve to the left. Lining up of the frame 26 for drilling under these circumstances requires the use of both the slide arrangement 32 and the turntable 28. The turntable is configured so as to be rotatable through approximately 300° if required.

Housed within the control panel 80 is pneumatic and/or electronic control means configured such that when the frame 26 is fixed in a desired position with the jacks 74, 76 extended, the control means is activated by controls on the control panel and is configured such that each of the holes in two of the vertical lines of holes are drilled by the drills 70.

Similarly, when drilling roof bolt holes, jacks 96 are extended downwardly from the roof drilling booms 72 into contact with the floor 14 to support the drilling booms. The drills 73 are then activated and displaced along the roof drilling booms 74 to drill holes into the roof 12 within which anchor bolts can be secured. Once again, the

spacing between the roof drilling booms 72 can be varied in order to achieve the desired spacing of holes drilled in the roof.

The Inventor believes that the invention will provide a simplified tunnelling drill rig which can be transported along mine tunnels and use for drilling roof bolt support holes as well as the longer holes required for blasting of the tunnel face. In addition, the Inventor believes that the positioning of the frame 26 will be a relatively simple procedure without requiring the need for particularly skilled manpower and/or a complex and expensive computer control system. As a result, the Inventor believes that the drill rig will reduce manpower requirements thereby improving productivity. In addition, use of the drill rig will lead to an increase in safety since the operator is spaced from the tunnel face reducing the risk of injury due to rockfalls.

CLAIMS:

1. A drill rig for use in an underground mine which includes a boom support structure on which at least one drilling boom is displaceably mounted or mountable, the boom support structure being displaceable between an erect condition and a collapsed condition to facilitate transport of the drill rig in an underground mine.

2. A drill rig as claimed in claim 1, in which the boom support structure is in the form of a collapsible frame.

3. A drill rig as claimed in claim 2, which includes a wheeled chassis on which the frame is mounted.

4. A drill rig as claimed in claim 3, in which the frame is mounted on the chassis so that it is pivotally displaceable relative thereto about an upwardly directed pivot axis and is laterally displaceable relative thereto.

5. A drill rig as claimed in claim 4, which includes a turntable mounted on the chassis for rotation about the pivot axis and a slide arrangement whereby the frame is mounted on the turntable for lateral displacement relative thereto.

6. A drill rig as claimed in claim 5, which includes a pair of elongate transversely spaced apart frame supports connected to and protruding from the slide arrangement, the frame including a plurality of interconnected frame members, at least some of which are pivotally

connected to the frame supports to permit displacement of the frame between its erect and its collapsed conditions.

7. A drill rig as claimed in claim 6, in which the frame includes two transversely spaced sets of frame members, each set of frame members comprising a rear upright member and a front upright member which are pivotally connected to one of the frame supports, a bottom member pivotally connected to the front and rear upright members adjacent their lower ends and a top member pivotally connected to the front and rear upright members adjacent their upper ends such that in the erect condition of the frame, each set of frame members is generally in the form of a square or rectangle and in the collapsed condition of the frame, each set of frame members is in the form of a parallelogram, and a plurality of transverse connecting members connecting the sets of frame members together.

8. A drill rig as claimed in claim 7, which includes displacement means for displacing the frame between its erect and collapsed conditions.

9. A drill rig as claimed in any one of claims 3 to 8, inclusive, which includes retractable outrigger jacks mounted on the chassis.

10. A drill rig as claimed in any one of claims 2 to 9, inclusive, which includes at least two transversely spaced tunnelling drilling booms displaceably mounted on the frame.

11. A drill rig as claimed in any one of claims 2 to 10, inclusive, which includes at least one roof drilling boom displaceably mounted on the frame.

12. A drill rig as claimed in any one of claims 2 to 11, inclusive, which includes anchor means for anchoring the frame in position.

13. A drill rig as claimed in claim 12, in which the anchor means includes a plurality of pressurised fluid operated jacks.

14. A drill rig for use in an underground mine which includes

a boom support structure;

at least one tunnelling drilling boom adjustably mounted on the boom support structure; and

at least one roof drilling boom adjustably mounted on the boom support structure and extending generally orthogonally to the tunnelling drilling boom.

15. A drill rig as claimed in claim 14, which includes a wheeled chassis on which the boom support structure is mounted such that it is pivotally displaceable relative to the chassis about an upwardly directed pivot axis and it is laterally displaceable relative to the chassis.

16. A drill rig as claimed in claim 15, which includes a turntable mounted on the chassis for rotation about the pivot axis and a slide arrangement whereby the boom support structure is mounted on the turntable for lateral displacement relative thereto.

17. A drill rig as claimed in any one of claims 14 to 16 inclusive, which includes a roof drilling boom support which is displaceable between an operative position in which it is in contact with a floor of a mine to provide support to the roof drilling boom and an inoperative position in which it is clear of the floor of the mine to facilitate transport of the drill rig in the mine.

18. A drill rig as claimed in claim 17, in which the roof drilling boom support is in the form of a jack mounted on and extendible downwardly from the roof drilling boom.

19. A drill rig as claimed in any one of claims 14 to 18 inclusive, in which the boom support structure is in the form of a collapsible frame.

20. A drill rig as claimed in any one of the preceding claims, which includes a control system for automatically controlling the operation of at least one of the drilling booms.

21. A drill rig as claimed in claims 1 or claim 14 substantially as herein described and illustrated.

22. A new drill rig substantially as herein described.

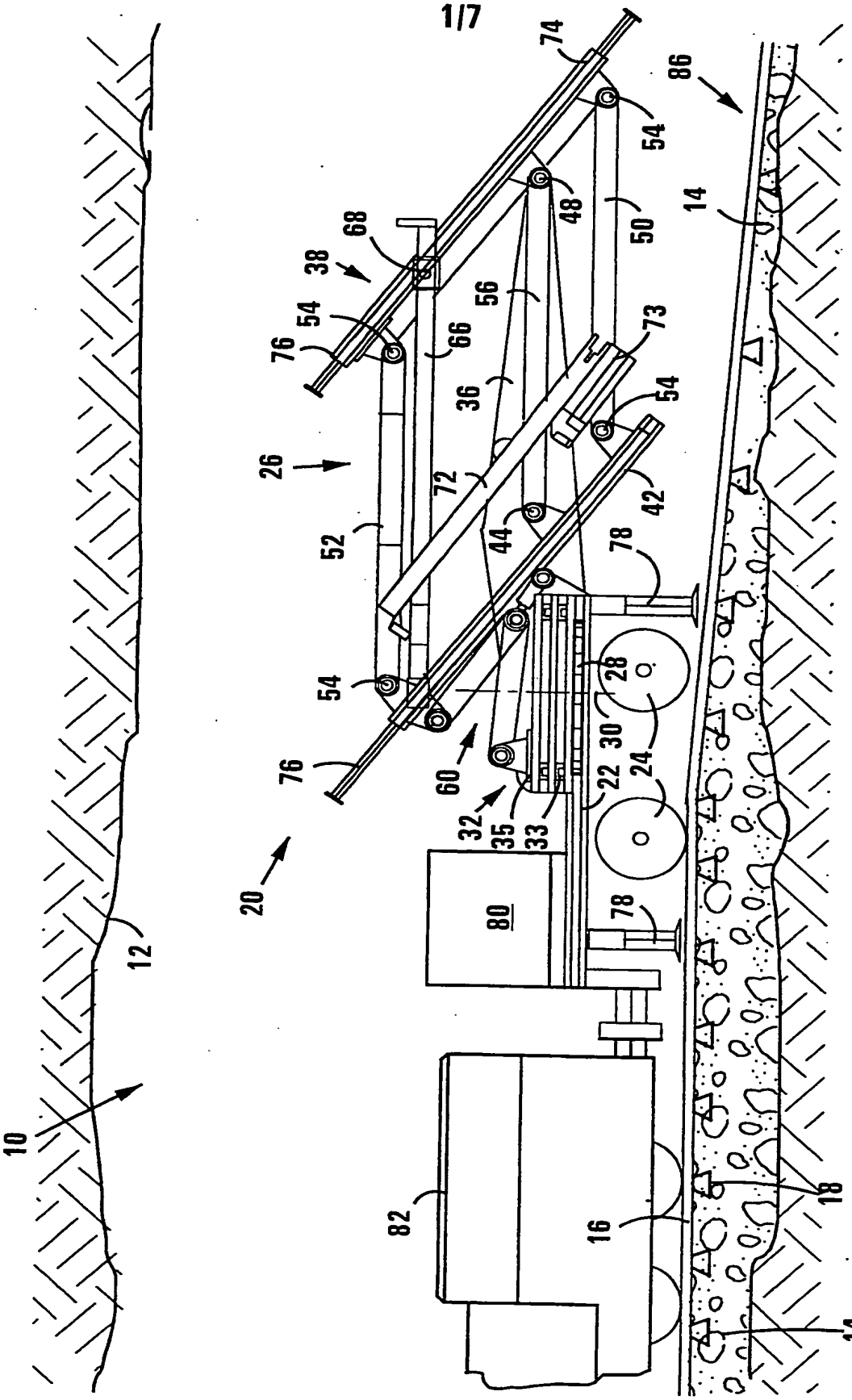
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FIG1

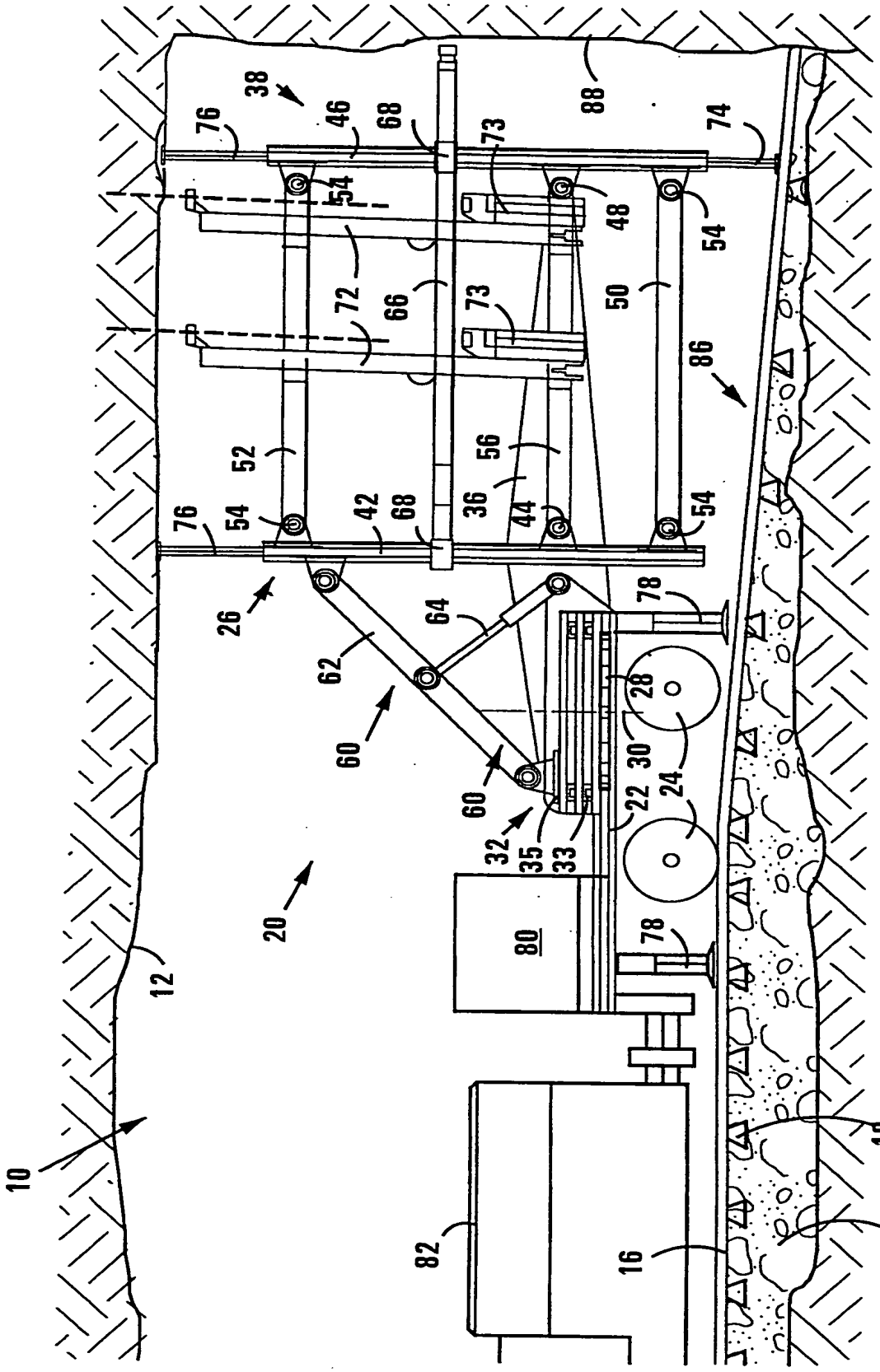
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FIG2

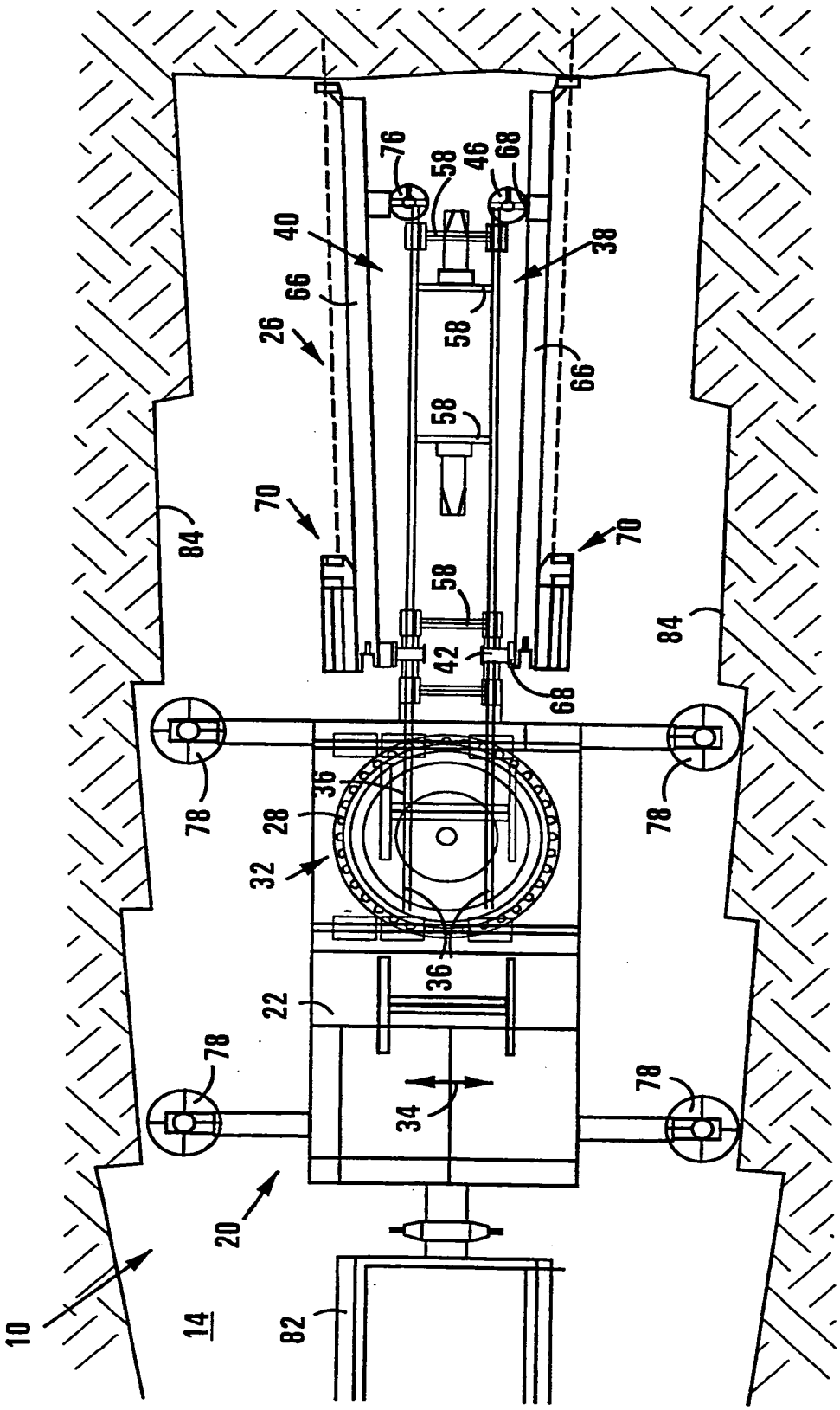
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FIG 3

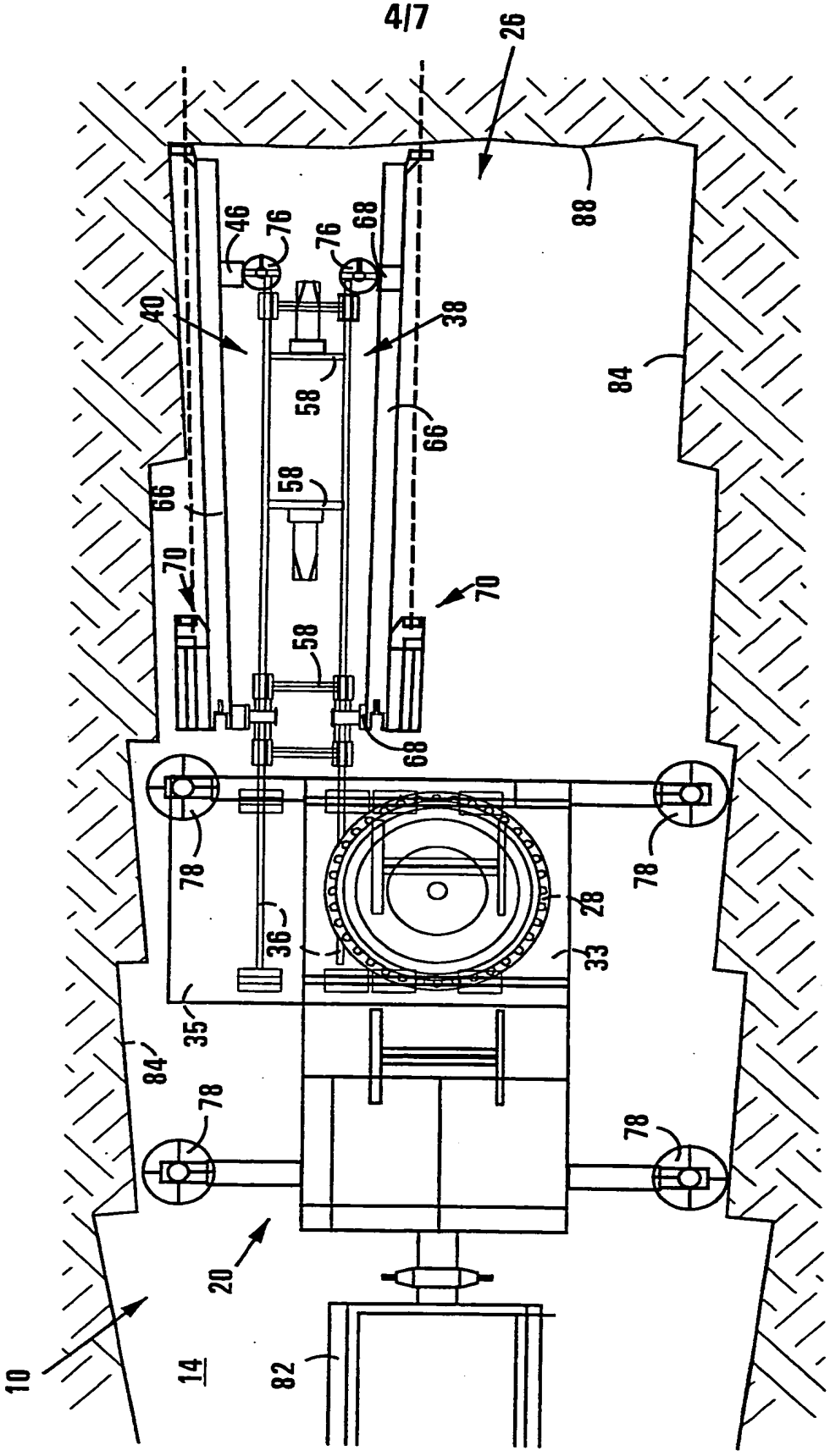
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FIG 4

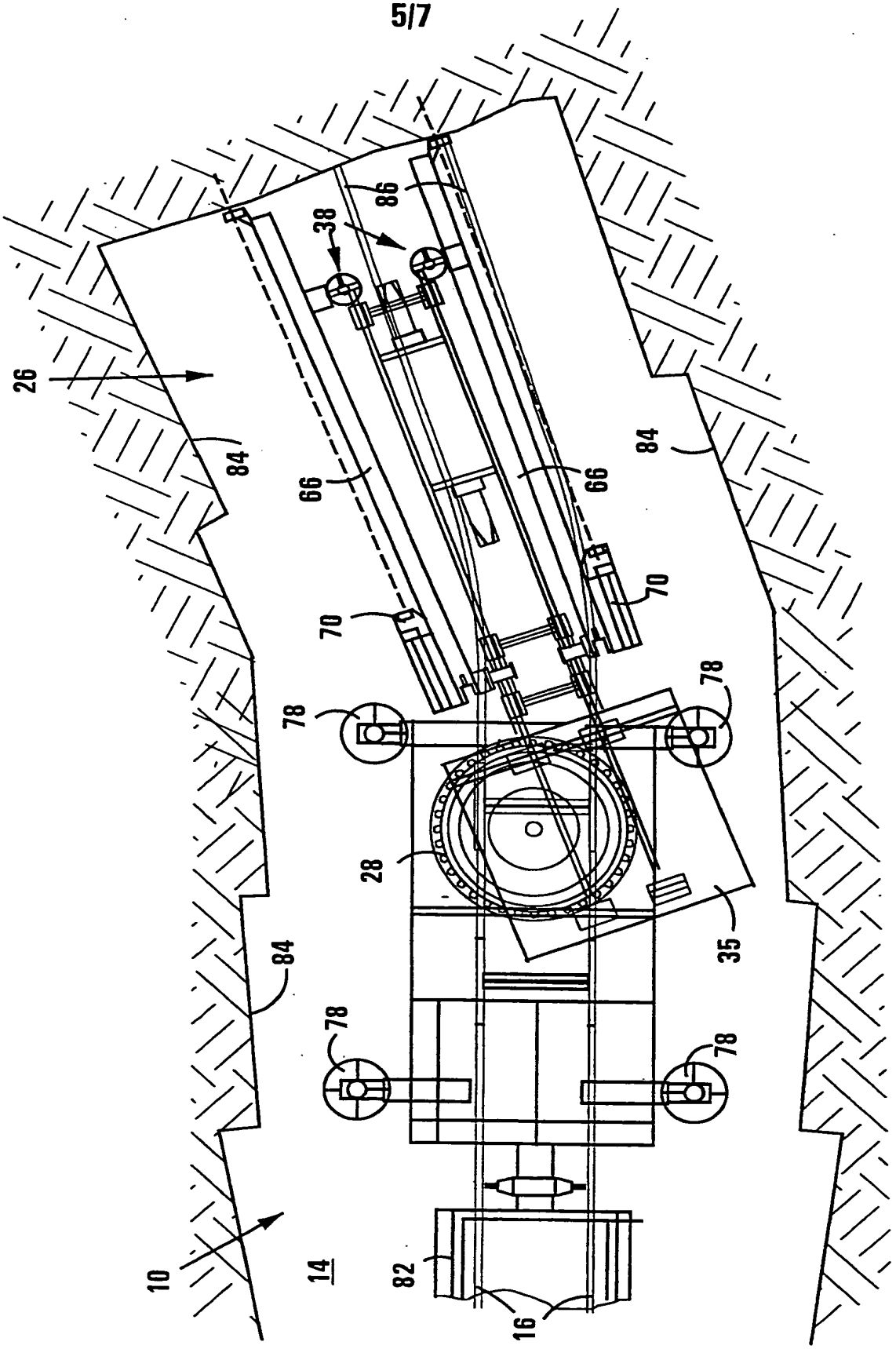


FIG 5

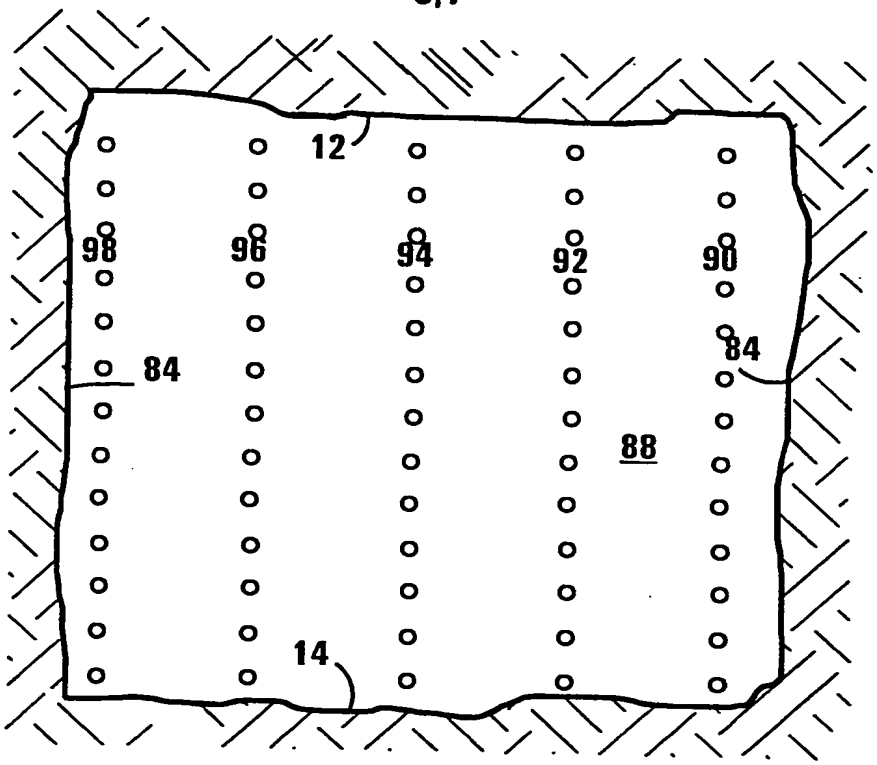
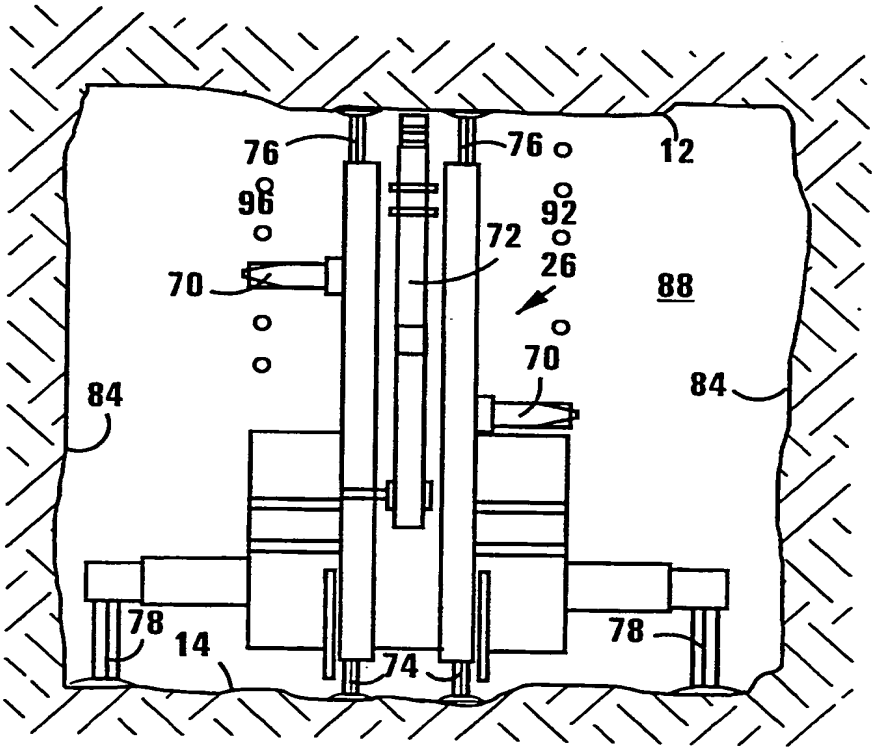

12
98
96
94
92
90
84
84
88
14

FIG 6


76
76
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92
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14
74
78

FIG 7

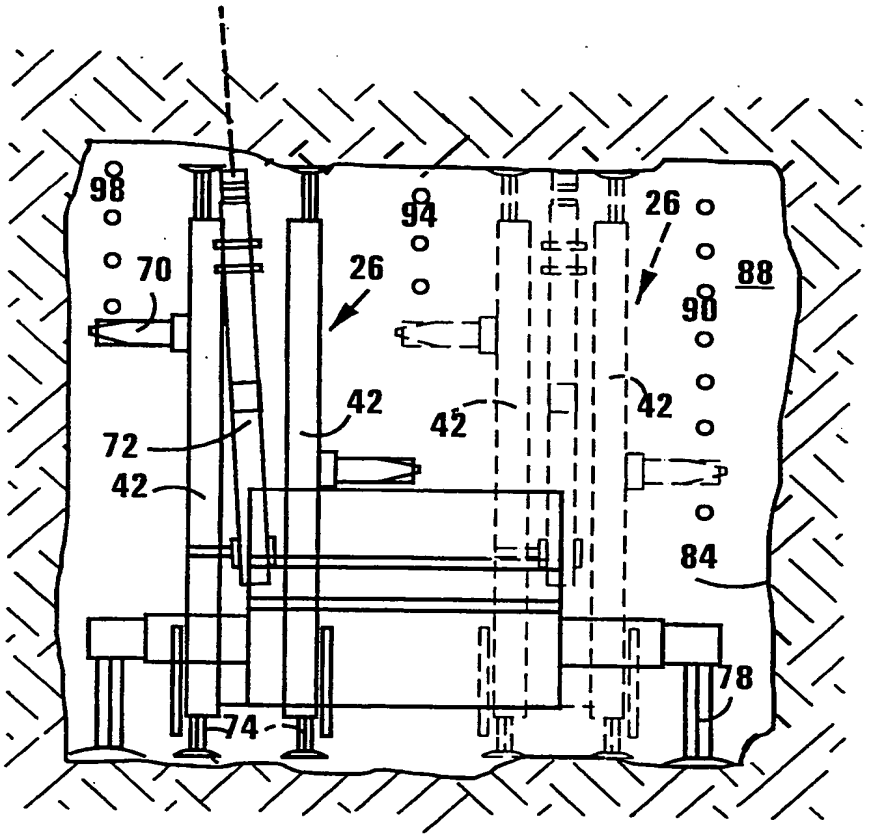

FIG 8

INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/IB 00/00418

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E21B15/04 E21D20/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E21B E21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 89 02513 A (BOGDANY BELA) 23 March 1989 (1989-03-23) page 13, line 8-20; figures 2,13-15,27 page 46, line 25 -page 47, line 10 page 58, line 33 -page 59, line 10	1-10,12, 13,20-22
Y	---	11,15-19
X	US 4 346 766 A (MANTEN HEINRICH) 31 August 1982 (1982-08-31) column 4, line 53 -column 5, line 12; figure 1	1-4,14, 15,21,22
X	---	
Y	US 5 050 934 A (BRANDL ERICH ET AL) 24 September 1991 (1991-09-24) figure 1	1,14 11,15-19
	--- -/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
26 June 2000	06/07/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	van Berlo, A

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 3 813 126 A (ROGNE C ET AL) 28 May 1974 (1974-05-28) figures 1,2	11,14-19
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